HTS/Ferroelectric Multilayer Thin Films for Microwave Applications

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Ferroelectric materials are non-linear dielectrics that present unique opportunities for advanced microwave signal processing devices. These devices are based on an electric field induced change in the dielectric constant. The use of ferroelectrics in microwave applications has been limited due to the large bias voltages required for bulk materials. However, in thin film form, bias voltages are reduced to low (0-10 V) values which would make these structures compatible with conventional semiconducting electronics. Among the more promising microwave applications are tunable phase shifters, mixers, delay lines, and filters. Device structures will require thin film insulators with a low dielectric constant and a low loss tangent (10^{-2} to 10^{-3}). Pulsed laser deposition (PLD) is a novel physical vapor deposition technique capable of producing high quality, multicomponent thin films and has led to the availability of several ferroelectric materials in thin film form suitable for device applications (e.g., $(Sr,Ba)TiO_3$, $Pb(Zr,Ti)O_3$ and $K(Ta,Nb)O_3$ and $(Sr,Ba)Nb_2O_3$). A further improvement in microwave device performance is expected from the use of high temperature superconducting (HTS) thin films with these ferroelectrics. PLD is uniquely suited to the integration of these two materials since multilayer structures can be generated simply by changing targets. At issue in the development of these devices are compatible processing conditions for the conductor and the insulator (e.g. substrate temperature, ambient composition and pressure), and the potential for interfacial reactions and epitaxy. We have deposited multilayer thin films of $YBa_2Cu_3O_{7-\delta}$ (YBCO) and ferroelectrics for microwave device applications. The results to be presented include DC and microwave transport characterization of the YBCO films as well as structural and morphological characterization of the multilayer.